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influence of a powerful faculty which the author has omitted, in this and other cases, to take sufficiently into account, — the faculty of imagination. The English language teaches us a lesson on this special point. In ordinary speech the adjective precedes its substantive; but the moment the language rises into poetry, the order tends to be reversed; and the higher the imagination, the stronger this tendency appears.

Thus we have in Byron —

"Adieu, adieu! My native shore
Fades o'er the waters blue."

And in Scott —

"Announced by prophet sooth and old,
Doomed doubtless for achievement bold."

And still more strikingly in Milton's picturesque epithets —

"Meadows trim, and daisies pied,
Shallow brooks, and rivers wide."

We can understand how a vivid fancy may bring the object itself first before the mental vision, and that a momentary delay may be needed to discriminate and express its most striking qualities. There is no question, also, that the Iroquois, like the Italians, are a highly imaginative people, much given, as the reports of their councils show, to poetical improvisations. And finally, if we are to inquire to what influences both Italians and Iroquois owe their imaginative powers, we may perhaps find them in what Buckle would have called the 'aspects of nature,' — the mountains, rivers, forests, and seas which surround them.

Mr. Byrne is of opinion that the 'inflected' idioms — a class which he restricts to the Indo-European and Semitic tongues — indicate the highest grade of intellect in their speakers. Our pride of race would lead us blushing to accept this compliment, until we find that we must share it with various barbarous septa, whom this pride of race would look down upon. Mr. Byrne, like other European scholars, — who cannot be altogether acquitted of race-prejudice in this respect, — has overlooked the fact that among the aboriginal tribes of America are several whose languages are as clearly inflective as the Greek or Arabic. Thus in Zeisberger's 'Delaware grammar' we find, as derivatives of *luen* ('to say'), *n'dellan* ('I say to thee'), *tellane* ('if I say to thee'), *lake* ('if I say to him'), and, in the imperative, *ill* ('say thou'), *luel* ('say on'), *lil* ('say to me'), *lo* ('say to him'), and the like. Pages might be filled with such examples of simple inflection, which, while they show clearly enough the polysynthetic cast of the language, have no more trace of the agglutinative cast than is to be found in any language of Europe. Duponceau, who translated this grammar

sixty years ago, remarked, in reference to the views which had been expressed on the subject by Baron William von Humboldt, "The learned baron will, I hope, recognize in the conjugations of the Delaware verbs those inflected forms which he justly admires; and he will find that the process which he is pleased to call 'agglutination' is not the only one which our Indians employ in the combination of their ideas and the formation of their words." The Delaware is not alone. On the other side of the continent, in the languages of Oregon, pure inflections abound. Thus the Sahaptin, as is shown in the excellent grammar of the Rev. A. B. Smith, has the substantive verb, *hiwash* ('to be'), — used, it may be remarked, exactly like our own substantive verb, — which in the 'remote past' tense makes *waka* (*a* as in 'father'), 'I was,' and in the 'recent past,' *waka* (*d* as in 'wall'), 'I have just been;' the only difference being in the change of the vowel-sound, precisely as in a Semitic conjugation.

What, then, shall we say? Shall we refuse to accept inflections as a proof of mental power? Or shall we more generously — and perhaps more scientifically — admit that they prove the barbarous speakers of these inflected American tongues to be equal in natural capacity to our own barbarous ancestors, the gifted inventors of the Aryan speech?

In spite, however, of such minor oversights, Mr. Byrne's work must be pronounced one of the most important and valuable among recent contributions to linguistic and ethnological science. The correctness of its main principles cannot reasonably be questioned; and the amount of information which the author has brought together and happily condensed, respecting a vast variety of languages spoken in every quarter of the globe, will make his treatise a treasury of reference for philologists.

H. HALE.

THEORETICAL OPTICS.

THE wave theory of light was so firmly established by the labors of Fresnel from 1815 to 1827, that but few leaders in physical science continued to defend the Newtonian theory after that time. The only logical objection to the undulatory theory was its supposed incapacity to explain the phenomenon of dispersion, although Fresnel had, with an acuteness almost peculiar to himself, suggested, as early as 1822, that this might find its explanation in the fact that the molecules of a transparent substance are not separated by

Theoretische optik gegründet auf das Bessel-Sellmeier'sche princip. Zugleich mit den experimentellen belegen. Von Dr. E. KETTELER. Braunschweig, Vieweg, 1885. 8°.

intervals indefinitely small compared to a wave-length of light. This suggestion was worked out by Cauchy between 1830 and 1835, and for a long time was supposed to complete the undulatory theory of light. But during the last few years the theory has undergone a very active critical revision by physicists, prompted by two capital discoveries; namely, the extraordinary relations between the electrical and optical properties of bodies, and the anomalous dispersion of light. Students of physics are well aware that these two discoveries are prompting rapid developments in two distinct lines, — the electro-magnetic and the molecular theories of light.

This book by Dr. Ketteler is a very important contribution to the subject from the stand-point of molecular dynamics, the problems proposed and solved being much the same as those treated by Sir William Thomson in his lectures at Baltimore in 1884. Starting with Sellmeier's paper of 1872, on anomalous dispersion (which establishes certain differential equations closely allied to Bessel's differential equation of the motion of a pendulum in air), the author passes in review the theories of Helmholtz, Meyer, and Lommel, and then develops his own, which differs from the others in its assumptions as to the nature of the reaction of the molecules of matter upon the ether. It is well known that the essential feature of these theories is that the molecules of gross matter have, in general, definite periods of vibration comparable to the periods of light waves, and also (since Sellmeier) that they are subject to a 'damping' effect. As in this treatment the absorption of the medium becomes of equal physical importance with its refractive power, Ketteler proposes to define as the law of dispersion the equation containing complex variables, expressing both the curve of refraction and the curve of absorption.

With this basis, the author derives a law of refraction for transparent bodies and those having a single symmetrical absorption band, which contains only four constants, and which satisfies observations remarkably well. Even for the flint glass for which Langley has given indices corresponding to wave-lengths from 2.36 to 0.34 (i.e., for relative wave-lengths varying from one to seven), the formula seems to be wholly adequate. This must certainly be regarded as a remarkable feat; but, as the author concludes (p. 445) that he has accounted for all the phenomena of light except phosphorescence and fluorescence, this alone does not establish the claim of the book to unqualified praise. It is true that his treatment leads to the accepted solutions of Fresnel for the phenomena of reflection, refraction,

and double refraction; but whether the processes are strictly legitimate may perhaps rest under some suspicion, in view of the fact that no one, before him at least, has succeeded in establishing a satisfactory theory for all of these phenomena on the basis of molecular dynamics. Even Sir William Thomson, in the Baltimore lectures, who approaches the problems from a stand-point not unlike that of Ketteler, except that he dispenses with terms involving viscosity as unphilosophical, emphasizes the statement that double refraction does not yield to the method.

It is a curiosity worth noting, that the author's theory explains the enormous dispersion of bisulphide of carbon, not by the great 'dispersive power' as defined by the second constant in Cauchy's equation, but by the exceptionally great wave-length of its absorption band, which is calculated as equal to 0.220.

The discussion of the electro-magnetic theory of light is suggestive, and, did it not demand too much space, some of it might well be quoted. This closes the first part of the book. The second part, of about two hundred pages, is devoted to the discussion of the author's experiments to test his theories: they, of course, largely relate to the phenomena of anomalous dispersion.

THE ROTIFERA.

WE have the pleasure of reviewing a very excellent work, which will be as welcome to the amateur and microscopist as serviceable to the professional zoölogist; for, to judge by the two parts already issued, the monograph of the Rotifera, by Mr. Hudson and Mr. Gosse, will be excellent throughout. The work is to be in two volumes of three parts each, with over thirty double plates, of which nearly all are to be colored. Its aim is to monograph the known species of the class, giving an improved classification, and including such anatomical observations as can be made upon the living specimens.

In accordance with this aim, the first chapter is an outline of the anatomy of the group Brachionus rubens, serving as type of the class; the descriptions, which are clear, being helped out by a plate of fairly good anatomical figures. The chapter is satisfactory, except that Mr. Hudson has indulged in the freak of describing the excretory apparatus, or, as it is often called in view of its homologies, the segmental organs, under the head of 'vascular system.' This is the same surprise to us that it would be to find the kidney

The Rotifera; or, Wheel animalcules. By C. T. HUDSON, assisted by P. H. GOSSE, F.R.S. Parts i. and ii. London, Longmans, 1885. 8°.